

CLAIMS

1. A security element (2) comprising a layer composite (1) with microscopically fine optically effective structures (9) of a surface pattern (12), which are embedded between layers (5; 6) of the layer composite (1), wherein the optically effective structures (9) are shaped into a reflecting interface (8) between the layers (5; 6) in surface portions (13; 14; 15) of a security feature (16) in a plane of the surface pattern (12), which is defined by co-ordinate axes (x; y),

characterised in that

at least one surface portion (13; 14; 15) of dimensions greater than 0.4 mm has a diffraction structure (S; S*; S**) formed by additive or subtractive superimposition of a superimposition function (M) describing a macroscopic structure, with a microscopically fine relief profile (R), wherein the superimposition function (M), the relief profile (R) and the diffraction structure (S; S*; S**) are functions of the co-ordinates (x; y) and the relief profile (R) describes a light-diffracting or light-scattering, optically effective structure (9) which, following the superimposition function (M), retains the predetermined relief profile (R), and that the at least portion-wise steady superimposition function (M) is curved at least in partial regions, is not a periodic triangular or rectangular function and changes slowly in comparison with the relief profile (R).

2. A security element (2) as set forth in claim 1 characterised in that the security feature (16; 16') has at least two adjacent surface portions (13; 14; 15) and that the first diffraction structure (S) is shaped in the first surface portion (14) and the second diffraction structure (S*; S**) which differs from the first diffraction structure (S) is shaped in the second surface portion (13; 15), wherein the grating vector or the preferred direction of the first relief profile (R) in the first surface portion (14) and the grating vector or the preferred direction of the second relief profile (R) in the second surface portion (13; 15) are directed substantially parallel.

3. A security element (2) as set forth in claim 1 or claim 2 characterised in that the superimposition function (M) is an asymmetrical, portion-wise steady, periodic function with the spatial frequency (F) of at most 5 lines/mm.

4. A security element (2) as set forth in claim 1 or claim 2 characterised in that the superimposition function (M) describes a relief image.

5. A security element (2) as set forth in one of claims 1 through 3 characterised in that in the diffraction structure (S; S*; S**) the grating vector or the preferred direction of the relief profile (R) is substantially parallel to a gradient plane which is determined by the gradient (38) of the superimposition function (M) and a surface normal (21) which is perpendicular to the surface of the layer composite (1).

6. A security element (2) as set forth in one of claims 1 through 5 characterised in that in a first surface portion (14) the first diffraction structure (S) is formed from the sum of the relief profile (R) and the superimposition function (M) and that in a second surface portion (13; 15) the diffraction structure (S*) is the difference (R - M) of the same relief profile (R) and the same superimposition function (M).

7. A security element (2) as set forth in one of claims 1 through 4 characterised in that in the diffraction structure (S; S*; S**) the grating vector or the preferred direction of the relief profile (R) is substantially perpendicular to a gradient plane which is determined by the gradient (38) of the superimposition function (M) and a surface normal (21) which is perpendicular to the surface of the layer composite (1).

8. A security element (2) as set forth in claim 2 or claim 3 or claim 7 characterised in that in the first surface portion (14) the first diffraction structure (S) is formed from the sum of the relief profile (R) and the

superimposition function (M) and that in the second surface portion (13; 15) the diffraction structure (S**) is the mirrored first diffraction structure (S).

9. A security element (2) as set forth in one of claims 1 through 8 characterised in that at least one identification mark (37) is arranged on at least one of the surface portions (13; 14; 15) and that the identification mark (37) establishes a predetermined viewing direction (39), wherein at least one strip (40) or spot (42) which is lit up by diffracted light (34) and which is displaceable on the illuminated surface portion (13; 14; 15) by means of tilting and rotating the security feature (16) is oriented to the identification mark (37).

10. A security element (2) as set forth in one of claims 1 through 9 characterised in that in at least one surface portion (13; 14; 15) the diffraction structure (S) is the sum of the superimposition function (M) and a diffraction structure (32) which is described by means of the relief profile (R) and which has a spatial frequency (f) and the superimposition function (M) has a local inclination (γ), that upon perpendicular illumination with white light (11) light (34) diffracted at the surface portion (13; 14; 15) is deflected at symmetrical viewing angles ($+\vartheta$; $-\vartheta$) which are predetermined with respect to the incident light (11), that the diffracted light (34) includes first beams (44) of a first wavelength (λ_1) at the one viewing angle ($+\vartheta$) and second beams (45) of a second wavelength (λ_2) at the other viewing angle ($-\vartheta$), wherein for the predetermined viewing angle (ϑ) and the predetermined spatial frequency (f) the sum of the two wavelengths (λ_1 ; λ_2) of the beams (44; 45) is proportional to the cosine of the local inclination (γ).

11. A security element (2) as set forth in claim 10 characterised in that the surface portion (13; 14; 15) adjoins a background field (46) of the security feature (16), that the diffraction grating (32) with the relief profile (R) is shaped into the background field (46) and that the spatial frequency

(f) of the diffraction grating (32) is such that at the viewing angles (+ θ ; - θ) the first beams (44) and the second beams (45) are of the first wavelength (λ_1).

12. A security element (2) as set forth in one of claims 1 through 3 characterised in that in each period of the superimposition function (M) the azimuth angles (ϕ) and/or the spatial frequencies (f) of the relief profile (R) are altered in accordance with the local inclination (γ) of the superimposition function (M) stepwise in partial surfaces (46) or continuously in a predetermined azimuth angle range ($\delta\phi$) or in a predetermined spatial frequency range (δf).

13. A security element (2) as set forth in one of claims 1 through 12 characterised in that the relief profile (R) is a diffraction grating (32) with a spatial frequency (f) of greater than 300 lines/mm.

14. A security element (2) as set forth in one of claims 1 through 12 characterised in that the relief profile (R) is a matt structure.

15. A security element (2) as set forth in one of claims 1 through 14 characterised in that adjacent extreme values of the superimposition function (M) in the surface portion (13, 14, 15) are remote from each other by at least 0.025 mm.

16. A security element (2) as set forth in one of claims 1 through 15 characterised in that the diffraction structure (S; S*; S**) is restricted to a structure height (H_{St}) of less than 40 μm and the superimposition function (M) is restricted to a variation value (H) of less than 30 μm , wherein the value z of the superimposition function (M), which is used in the diffraction structure (S; S*; S**), is equal to $\{(M) + C(x; y)\}$ modulo variation value (H) - $C(x; y)$, wherein the function $C(x; y)$ is restricted in amount to half the structure height (H_{St}).

17. A security element (2) as set forth in one of claims 1 through 16 characterised in that surface elements (17; 18; 19) having the optically effective structures (9) are parts of the surface pattern (12) and that at least one of the surface elements (17; 18; 19) adjoins the security feature (16).